

ENERGY DESIGN ASSISTANCE

Verification Report

Bishop H. Whipple Federal Building Minneapolis, Minnesota



THE WEIDT GROUP®
TWGI.COM

Energy Design Assistance Program

October 31, 2014
4014268 (7226.58)

Prepared for



414 Nicollet Mall, 6th Floor
Minneapolis, MN 55401
612.330.6850
xcelenergy.com/businessnewconstruction

By

THE WEIDT GROUP®



twgi.com

Minneapolis
Des Moines

Madison

Denver
Tampa

Executive Summary

This report continues the Energy Design Assistance Program for the Bishop H. Whipple Federal Building.

Xcel Energy offers the Energy Design Assistance Program as assistance to owners and design teams to evaluate potential energy conservation strategies for new and renovated building projects during the design and construction processes.

During the design phase, the building Owner selected a number of energy conservation strategies. In response, Xcel Energy offered an incentive for the implementation of these strategies.

The new construction work has been completed and Xcel Energy has verified that many of these conservation strategies have been installed. These measures provide projected energy cost savings of over \$485,400 per year, in relation to the building baseline. Table A, below, provides further economic analysis of the energy conservation investments.

Table A. Energy Conservation Investments - Simple Payback Analysis

| | |
|---------------------------------------|-------------|
| Project Incremental Construction Cost | \$8,552,884 |
| Xcel Energy Incentive | \$142,800 |
| Project Adjusted Incremental Cost | \$8,410,084 |
| Annual Energy Cost Savings | \$485,461 |
| Payback, with incentive (in years) | 17.3 |

The simple payback analysis shows that the Xcel Energy incentive has helped reduce the incremental costs associated with the energy conservation strategy investments in this building, resulting in a payback of 17.3 years.

For more information, please refer to the following report.

Table of Contents

| | |
|-----------------------------|----|
| Executive Summary..... | 1 |
| Introduction | 4 |
| Process | 4 |
| Strategy Summary List | 5 |
| Summary of Results | 20 |
| Building Summary | 22 |

Project Participants

Design Team

Owner General Service Administration
Michael Doede
Nathan Ingersoll
Timothy Kludt
Keith Kennedy
Kathryn Leonardo
Michael Messerle
John Natwick
Anthony Venticinque
David Wolken

Architect and Engineer HGA
Debra Young
Mark Zevenbergen
Sarah Berseth
Chrysanthi Stockwell
Michael Woodson
Jennifer McMaster
Mark Johnson
Kimberly Sandbulte

Contractor Ryan Companies US
Brad Whitmore
Nate Day
Peter Bangasser
Troy Corrigan

Energy Design Assistance Team

Electric Utility Xcel Energy
Mike Davidovich
Kris Kohls
Ami Shapiro

Energy Design Assistance Consultant The Weidt Group
Jim Douglas
Adam Niederloh

Verification Consultant..... The Weidt Group
Chris Iacono

Introduction

This Report documents the results of verification for several energy conservation strategies (compared to a baseline model) for the Bishop H. Whipple Federal Building project.

The Weidt Group visited the Bishop H. Whipple Federal Building on August 19, 2014. During this visit we verified the energy conservation strategies that had been chosen for implementation. In addition, select lighting and mechanical strategies were datalogged during this time period and the results are included in this report.

The report follows the previous Energy Design Assistance Program Report (from June 01, 2011) for the project and serves as a final document for verifying energy savings strategies implemented at this new building located in Minneapolis, Minnesota.

The Energy Design Assistance Program requires the Owner and Design Team to commit to one of the bundle alternatives identified in the Bundle Report from June 01, 2011. Upon selection, The Weidt Group verifies the selected strategies via Construction Documents review, construction submittals, and on site verification of the strategies selected.

For this project, the Owner selected Bundle 4M for implementation. For more information about Bundle 4M composition and strategy results, please see the previous Energy Design Assistance Program reports, as noted above.

Process

The following list provides the process steps for this energy conservation program.

Energy Design Assistance Program

- Establish goals and intentions
- Computer modeling of baseline, strategies, and bundles

Bundle Selection by the Owner

Bundle Requirements Document

- Summarizes key features/verification plan for all bundle strategies

Construction Documents Review

- Reviews drawings to locate the energy conservation measures and notify the Design Team of any changes from the selected bundle

Field Verification Study (following project completion and occupancy)

- Request submittals (e.g., glazing, insulation, cooling, heating plants)
- Locate the energy conservation measures on site

Final Verification Report

- **Detail the findings of the verification process**
- **Estimate of final energy savings for the building**
- **Document final incentive**

Xcel Energy Incentive Payment

Strategy Summary List

The following table provides a complete list of the modeled energy conservation strategies that were selected by the Design Team for installation.

Table 1. Bundled Strategies and Verification Results

| ID | Strategy Description | Portion of Total kW Savings Verified |
|----------------------|---|--------------------------------------|
| Architectural | | |
| EWC01 | R-16 wall assembly (2 in. additional insulation) | 2% |
| ERC01 | R-50 wall assembly (15% of roof area) | 2% |
| W1901 | Lo E tint, high visible transmittance/ improved thermal break | 1% |
| Electrical | | |
| D3207 | Private Office Dimming Daylighting Control | 3% |
| D3208 | Open Office Dimming Daylighting Control | 14% |
| D3204 | Vestibule Stepped Daylighting Control | <1% |
| D3211 | Dining Stepped Daylighting Control | <1% |
| D3224 | Sally port Dimming Daylighting Control | <1% |
| D3225 | Fitness Stepped Daylighting Control | <1% |
| LCPO3 | Private office dual level occupancy sensor control | 2% |
| LCPO1 | Private office occupancy sensor control | 1% |
| LCCN3 | Conference dual level occupancy sensor control | 1% |
| LCCN4 | Conference dual level switching | <1% |
| LCCN5 | Conference manual dimming | 1% |
| LCDC1 | Data center occupancy sensor control | <1% |
| LCST1 | Storage occupancy sensor control | 1% |
| LCRR1 | Restroom occupancy sensor control | <1% |
| LCAU5 | Auditorium manual dimming | 1% |
| LCFT1 | Fitness occupancy sensor control | <1% |
| LCWA1 | Waiting occupancy sensor control | <1% |
| LCX2 | Exam occupancy sensor control to 1/3 level | <1% |
| LCSP1 | Sally Port occupancy sensor control | <1% |
| LCDN1 | Dining occupancy sensor control | <1% |
| LCLR1 | Locker Room & Shower occupancy sensor control | <1% |
| L04GR | 26% reduction beyond ASHRAE 90.1 - 2007 Baseline | 25% |

| ID | Strategy Description | Portion of Total kW Savings Verified |
|----------------------|--|--------------------------------------|
| Mechanical | | |
| MWW01 | Water to Water Heat Pumps (Ground Coupled), Alternate 1 | 5% |
| MMT03 | Premium efficiency supply/return fan motors | 1% |
| MMT04 | Premium efficiency pump motors | <1% |
| MLR02 | VFDs on supply/return air fans | <1% |
| MHRT1 | Total heat recovery | 22% |
| MOA02 | CO2 control of outside air | 12% |
| MOA22 | CO control of garage vent fans w/ Sensible Heat Recovery (Motor Pool and Sally Port) | <1% |
| MHW03 | 96% SHW Efficiency for 40% load (Solar for 60%) | <1% |
| Plug Loads | | |
| MTR01 | High efficiency transformers | 10% |
| Total Savings | | 100% |

Individual Strategy Verification Results

The following table(s) provides the field verification detailed findings for the applicable strategies. In addition, the Appendices have further information and calculations.

Architectural Strategy Verification Results

| ID | Strategy Description | Verification Review | Verification Findings |
|-------|---|-------------------------|---|
| EWC01 | R-16 wall assembly (2 in. additional insulation) | R-16 | The verified wall insulation meets the strategy requirements. |
| ERC01 | R-50 wall assembly (15% of roof area) | R-50 | The verified roof insulation meets the strategy requirements. |
| W1901 | Lo E tint, high visible transmittance/ improved thermal break | 0.26/0.25 U-factor COG | The verified U-Factor meets the strategy requirements. |
| | | 0.34/0.33 U-factor Unit | The verified SHGC meets the strategy requirements. |
| | | 0.33/0.37 SHGC | |
| | | 0.53/0.70 Vis Trans | |

Electrical Strategy Verification Results

| ID | Strategy Description | Verification Review | | Verification Findings |
|-------|--|---------------------|-----------------|--|
| D3207 | Private Office Dimming Daylighting Control | 22,900 | Control Area sf | The verified control area meets the strategy requirements. |
| D3208 | Open Office Dimming Daylighting Control | 82,100 | Control Area sf | The verified control area meets the strategy requirements. |
| D3204 | Vestibule Stepped Daylighting Control | 1,000 | Control Area sf | The verified control area meets the strategy requirements. |
| D3211 | Dining Stepped Daylighting Control | 1,000 | Control Area sf | The verified control area meets the strategy requirements. |
| D3224 | Sally port Dimming Daylighting Control | 7,200 | Control Area sf | The verified control area meets the strategy requirements. |
| D3225 | Fitness Stepped Daylighting Control | 700 | Control Area sf | The verified control area meets the strategy requirements. |
| LCPO3 | Private office dual level occupancy sensor control | 16,000 | Control Area sf | The verified control area meets the strategy requirements. |
| LCPO1 | Private office occupancy sensor control | 22,900 | Control Area sf | The verified control area meets the strategy requirements. |
| LCCN3 | Conference dual level occupancy sensor control | 17,400 | Control Area sf | The verified control area meets the strategy requirements. |
| LCCN4 | Conference dual level switching | 4,200 | Control Area sf | The verified control area meets the strategy requirements. |
| LCDC1 | Data center occupancy sensor control | 6,100 | Control Area sf | The verified control area meets the strategy requirements. |
| LCST1 | Storage occupancy sensor control | 32,500 | Control Area sf | The verified control area meets the strategy requirements. |
| LCRR1 | Restroom occupancy sensor control | 15,800 | Control Area sf | The verified control area meets the strategy requirements. |
| LCFT1 | Fitness occupancy sensor control | 3,000 | Control Area sf | The verified control area meets the strategy requirements. |
| LCWA1 | Waiting occupancy sensor control | 400 | Control Area sf | The verified control area meets the strategy requirements. |
| LCEX2 | Exam occupancy sensor control to 1/3 level | 2,300 | Control Area sf | The verified control area meets the strategy requirements. |
| LCSP1 | Sally Port occupancy sensor control | 10,100 | Control Area sf | The verified control area meets the strategy requirements. |
| LCDN1 | Dining occupancy sensor control | 1,200 | Control Area sf | The verified control area meets the strategy requirements. |
| LCLR1 | Locker Room & Shower occupancy sensor control | 2,000 | Control Area sf | The verified control area meets the strategy requirements. |
| LCCN5 | Conference manual dimming | 21,600 | Control Area sf | The verified control area meets the strategy requirements. |
| LCAU5 | Auditorium manual dimming | 4,300 | Control Area sf | The verified control area meets the strategy requirements. |
| L04GR | 26% reduction beyond ASHRAE 90.1 - 2007 Baseline | 0.75 | Control Area sf | The average verified Watts/sq ft meets the strategy requirements. Refer to the following page for space by space findings. |

Space Type Lighting Power Density

| Space Type | Baseline lighting power (W/sf) | Takeoff Lighting power (W/sf) |
|-------------------------|--------------------------------|-------------------------------|
| Private office | 1.10 | 0.83 |
| Open office | 1.10 | 0.80 |
| Conference | 1.30 | 1.47 |
| Data center | 1.10 | 0.90 |
| Corridor | 0.50 | 0.46 |
| Lobby | 1.30 | 1.35 |
| Dining | 0.90 | 1.19 |
| Kitchen/Serving | 1.20 | 0.93 |
| Storage | 0.80 | 0.80 |
| Mech/elec | 1.50 | 0.31 |
| Restroom | 0.90 | 1.16 |
| Office | 1.10 | 0.76 |
| Locker Room & Shower | 0.60 | 0.85 |
| Auditorium | 2.60 | 1.17 |
| Classroom | 1.40 | 1.40 |
| Loading dock | 0.80 | 0.83 |
| Motor Pool* | 0.20 | 0.20 |
| Sally Port | 0.20 | 0.41 |
| Fitness | 0.90 | 0.55 |
| Courtroom | 1.90 | 0.72 |
| Waiting | 0.50 | 0.66 |
| Exam | 1.50 | 0.89 |
| Vacant | 1.10 | 0.53 |
| Holding Room | 1.10 | 0.72 |
| Building Average | 1.01 | 0.75 |

*Based on confirmation from Mark Zevenbergen, motor pool lighting was not replaced as part of this project, and is assumed to meet Baseline.

Daylighting Controls – Datalog Results

Lighting was datalogged to verify the automatic daylighting controls in the open office spaces. A split-core CT was placed in panel L1-10 on circuit 2 to monitor amp loads in a typical 1st floor open office space. Five minute data was collected from September 16, 2014 to October 27, 2014.

Figure 1, below, shows lighting loads throughout the course of a week. The lights show variation in amp level, beginning around 12 amps in the early morning and decreasing to as low as 7 amps in the afternoon periods. This variation is likely due to the daylighting controls, which are dimming the lights when daylight is available.

Figure 1 – Open office lighting, Panel L1-10 Circuit #2, week of October 20, 2014

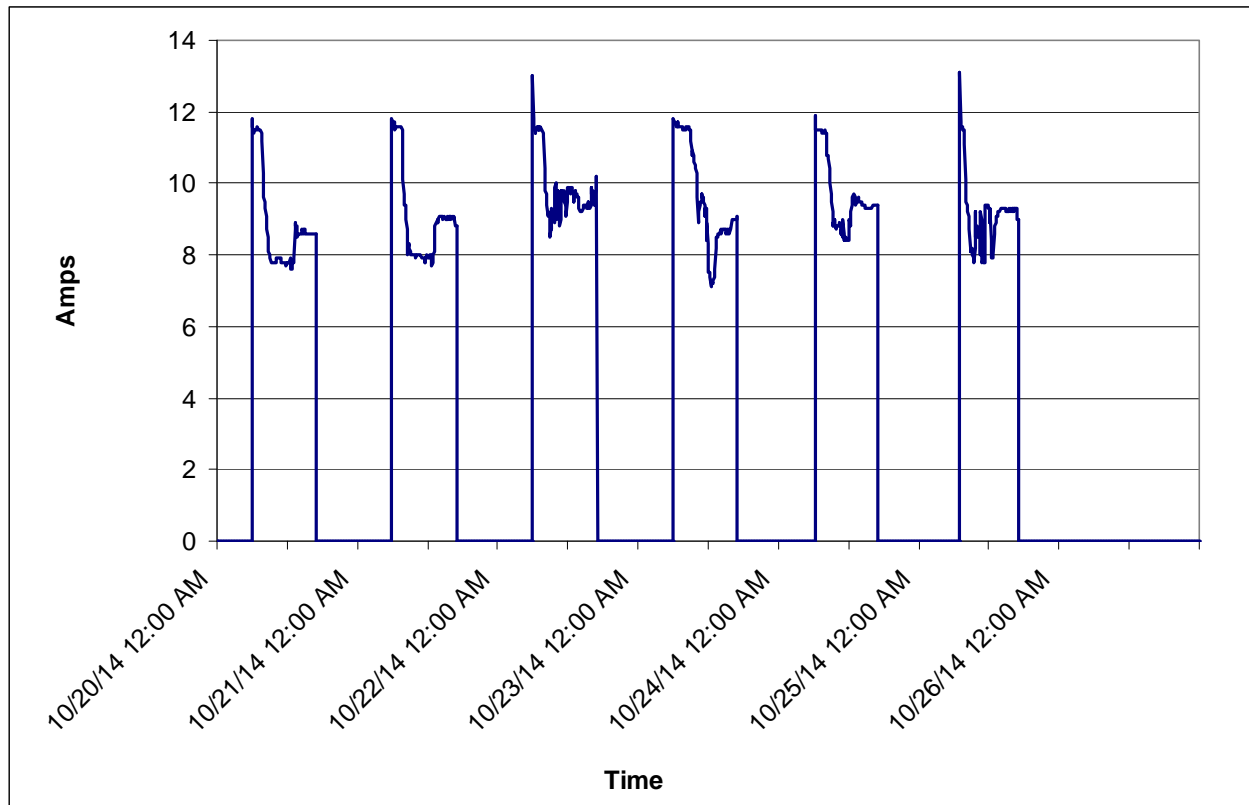
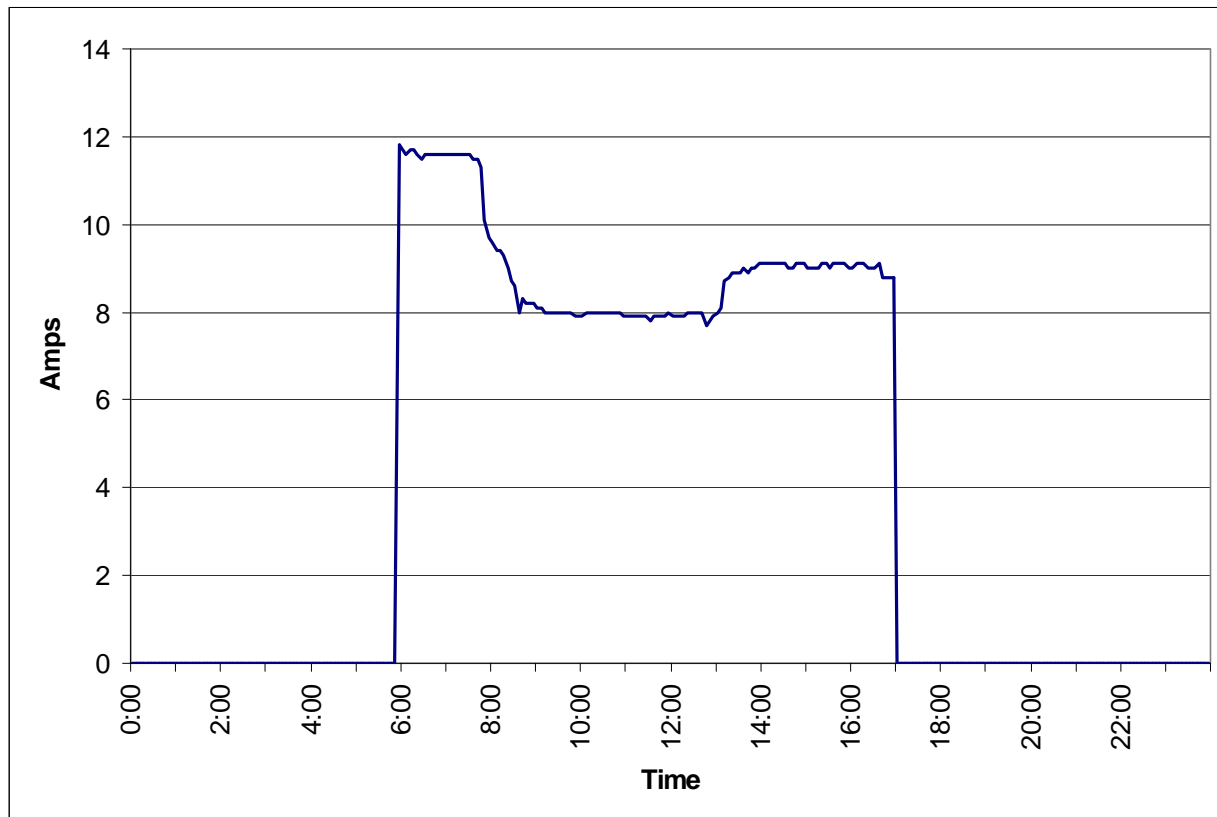


Figure 2, below, shows the open office lighting over the course of a typical day. The lights turn on at 6:00AM and rise to about 12 amps. Beginning around 7:30AM, the lights gradually decrease, stabilizing around 8 amps by 8:30AM. The dimming daylighting controls appear to be in effect during this period. The lights stay at 8 amps until around 1:00PM, at which time the lights increase to 9 amps. There may be less daylight available during the afternoon and the controls may have increased the lights to maintain the footcandle level in the space.

Based on the data collected, it appears that the daylighting controls are functioning as expected to reduce lighting energy consumption.

Figure 2 – Open office lighting, Panel L1-10 Circuit #2, October 21, 2014



Site Photos



Open office fluorescent lighting with dimming daylighting controls



Integral photosensor on open office light fixture



Typical office occupancy sensors



Sally port occupancy sensor

Mechanical Strategy Verification Results

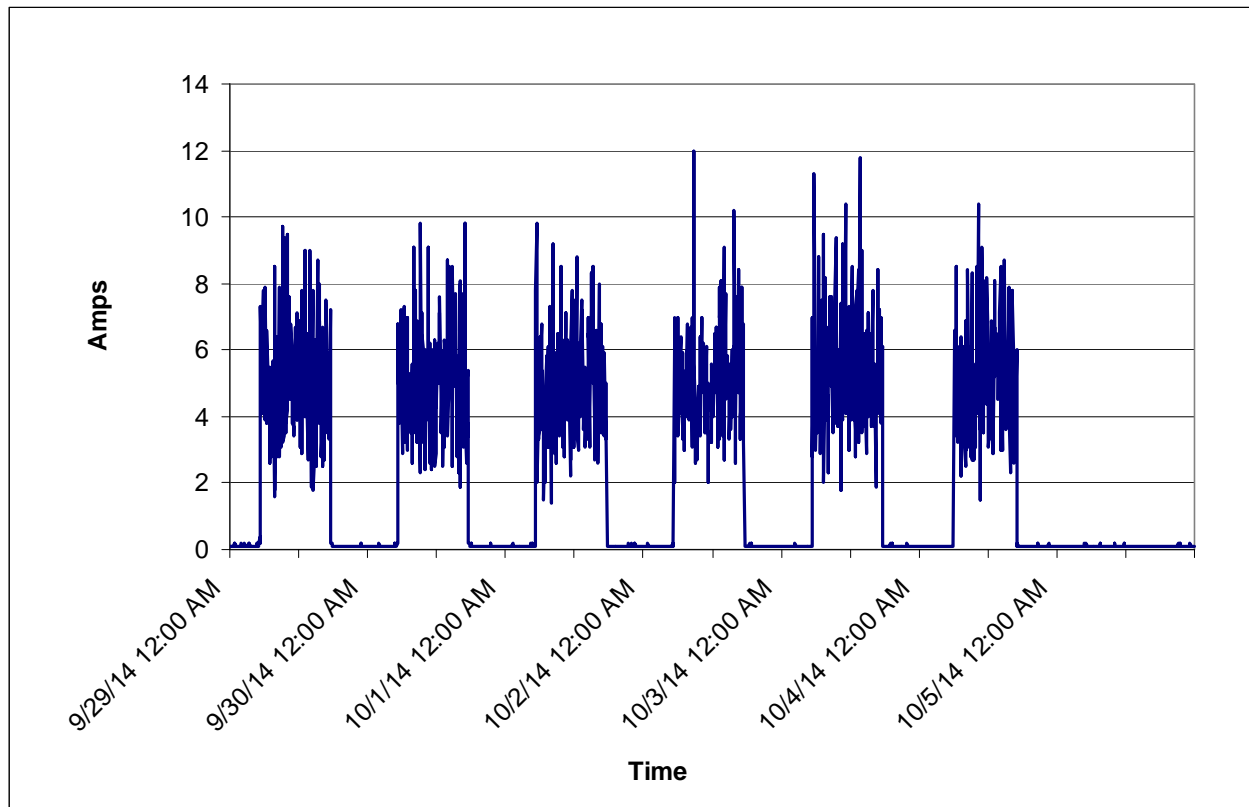
| ID | Strategy Description | Verification Review | | Verification Findings |
|-------|--|--|------------------|--|
| MWW01 | Water to Water Heat Pumps (Ground Coupled), Alternate 1 | 15 / 2.88 | EER/COP | The verified heat pumps meet the strategy requirements. |
| MMT03 | Premium efficiency supply/return fan motors | Premium | Rating | Premium efficiency motors were found as expected. |
| MMT04 | Premium efficiency pump motors | Premium | Rating | Premium efficiency motors were found as expected. |
| MLR02 | VFDs on supply/return air fans | VFD | Motor control | The supply/ return fan VFDs have been installed as expected. |
| MHRT1 | Total heat recovery | 83% Sensible/ 73% Latent @ 72% exhaust-to-intake ratio | Efficiency ratio | The verified heat recovery units meet the strategy requirements. |
| MOA02 | CO2 control of outside air | Reset OA | Control Type | The verified CO2 controls meet the strategy requirements. |
| MOA22 | CO control of garage vent fans w/ Sensible Heat Recovery (Motor Pool and Sally Port) | CO control | Control Type | The verified CO controls and heat recovery meet the strategy requirements. |
| MHW03 | 96% SHW Efficiency for 40% load (Solar for 60%) | 96% | Efficiency | The verified service water heating system meets the strategy requirements. |

Fan VFD Control – Datalog Results

Similar to the lighting controls, a supply fan motor was datalogged to verify the supply fan VFD controls. A split-core CT was placed on the load side of the AHU-6 supply fan VFD to datalog the amp load on the fan motor. Five minute data was collected from September 16, 2014 to October 27, 2014.

Figure 3 below shows the supply fan profile over the course of a typical week. The amp load ranges from 2 amps to 12 amps during the week. The varying amp load suggests that the VFD is operating as expected by adjusting the fan speed to meet the building demand.

Figure 3 – AHU-6 supply fan VFD – week of September 29, 2014



Site Photos



Typical Fan VFD



Carbon monoxide (CO) sensors



Energy recovery unit



Premium efficiency pump motor

Plug Load Strategy Verification Results

| ID | Strategy Description | Verification Review | | Verification Findings |
|-------|------------------------------|---------------------|------------|---|
| MTR01 | High efficiency transformers | NEMA premium | Efficiency | The verified transformers meet the strategy requirements. |

Summary of Results

Table 2 provides summarized and updated field-verified energy savings projections for this new building.

Table 2. “As Verified” energy savings and energy cost savings

| Energy Parameter | Baseline* | Bundle 4M, As Verified** |
|---|----------------|-----------------------------|
| Energy Cost | \$1,013,245 | \$527,784 |
| Energy Cost Savings | | \$485,461 |
| Percent Energy Cost Savings | | 47.9% |
| Electricity Demand | 2,546 kW | 1,969.27 kW |
| Electricity Demand Savings | | 576.73 kW |
| Percent Electricity Demand Savings | | 22.7% |
| Electricity Consumption | 11,880,611 kWh | 6,292,082 kWh |
| Electricity Consumption Savings | | 5,588,529 kWh |
| Percent Electricity Consumption Savings | | 47.0% |
| Natural Gas Consumption | 1,242 Dth | 556 Dth |
| Natural Gas Consumption Savings | | 686 Dth |
| Percent Natural Gas Consumption Savings | | 55.2% |
| | | |
| Incremental First Cost | | \$8,552,884 |
| Xcel Energy Incentive | | \$142,800 |

* The Baseline has been updated in the process of modeling the NEMA premium efficiency transformers strategy.

**A prescriptive rebate check in the amount of \$36,000 has already been issued for the pump motors installed at the building. The energy savings and incentive shown in the ‘Bundle 4M, As Verified’ column exclude the motors that have already been rebated.

Simple Payback Analysis

Table 3 shows the calculated simple payback for these energy investments with the included Xcel Energy incentive. The table also provides payback analysis of the As-Verified Bundle 4M.

Table 3. Bundle Simple Payback Analysis

| | Incremental Construction Cost | Xcel Energy Incentive | Adjusted Incremental Cost | Energy Savings vs Baseline | Payback w/ Incentive |
|-----------|-------------------------------------|--------------------------|---------------------------------|----------------------------------|----------------------------|
| Bundle 4M | \$8,552,884 | \$142,800 | \$8,410,084 | \$485,461 | 17.3 |

The simple payback analysis shows that the Xcel Energy incentive has helped reduce the incremental costs associated with the energy conservation strategy investments in this building, resulting in a payback of 17.3 years.

***Note:** Subject to the following qualifications, the computer model offers sophisticated predictions of energy savings with estimations as good as any other means available for a building that has not been built.*

The baseline and as-verified results compare relative differences in net energy use for design alternatives. The actual energy use of this building will be different from simulated results. Building systems and other operating parameters provided by the Design Team and modeled through this program approximate actual conditions, but differences in weather, operating parameters, occupancy level, and changes that occur through the bidding and construction process will result in annual energy costs that will be different from what is predicted here.

Thus, implementation of a bundle of strategies offers the opportunity for energy savings, but the realization of those savings is the responsibility of the owner/operator of the building- not The Weidt Group or Xcel Energy. Savings are not guaranteed.

Building Summary

| Building Summary | |
|---|---|
| Building type | Office, with Cafeteria |
| Location | Minneapolis, Minnesota |
| Building area | 583,843 sq ft |
| Number of stories | 8 |
| Building Structure | Masonry construction |
| Building organization | Office building, 7 floors, basement, approximately 1400 population |
| Windows | Punched opening (existing) Window to floor area ratio: 4.%; Window to wall area ratio: 18.2% |
| Lighting system(s) | Mostly lay-in 4-foot fluorescent fixtures |
| HVAC system(s) | Water-to-water heat pumps (ground coupled) VAV air handlers Dedicated Outdoor Air System with heat recovery |
| Areas heated | All |
| Areas cooled | All but SallyPort and MotorPool |
| Electric utility | Xcel Energy |
| Gas utility | Other |
| Approx. construction document completion date | September 2011 |
| Approx. construction start | August 2011 |
| Approx. occupancy date | July 2014 |